

Motion and Sound

3-5 The student will demonstrate an understanding of how motion and sound are affected by a push and pull on an object and the vibration of an object (Physical Science)

3-5.1 Identify the position of an object relative to a reference point by using position terms such as “above,” “below,” “inside of,” “underneath,” or “on top of,” and a distance scale or measurement.

Taxonomy level: 1.1-A, B Remember Factual and Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-5.1), students identified the location of an object relative to another object. Students have not been introduced to the concepts of identifying positions and motions of objects with terms and measurements in previous grades. Students will further develop this concept of position in 5th grade (5-5.2) when they will summarize the motion of an object in terms of position, direction, and speed.

It is essential for students to know that the position of an object can be identified by using a reference point.

- Terms, such as, “above,” “below,” “inside of,” “underneath,” “on top of” can be used to describe its relative location to another object.
- *Distance* is the length between two locations or positions.
- The distance of a specific object to another object can be measured using meter tapes, sticks, or rulers.
- This distance can be recorded in meters or centimeters.

It is not essential for students to read or record distance in millimeters.

Assessment Guidelines:

The objective of this indicator is to *identify* the location or position of an object relative to a reference point; therefore, the primary focus of assessment should be to recognize the position of an object compared to that of another object using terms that show positions (including “above,” “below,” “inside of,” “underneath,” or “on top of,”) or a distance scale to measure the distance. However, appropriate assessments should also require students to *recognize* the location or position of an object compared to another object using terms listed above or a distance scale or measurement from a meter tape, stick, or ruler in meters and/or centimeters.

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3-5.2 Compare the motion of common objects in terms of speed and direction.

Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-5.4), students illustrated ways in which objects can move in terms of direction and speed (including straight forward, back and forth, fast or slow, zigzag, and circular). Students will further develop this concept quantitatively in 5th grade (5-5.2) when they will summarize the motion of an object in terms of position, direction, and speed, and they will use a graph to illustrate the motion of an object (5-5.5).

It is essential for students to know that motion can be described in terms of speed and direction.

Direction

- Direction is the path/course along which something is moving.
- Examples of terms that describe the direction of a moving object relative to another object are: “up,” “down,” “left,” “right,” “north,” “south,” “east,” “west.”

Speed

- *Speed* is how fast an object moves.
- Faster objects move a greater distance than slower objects in a certain period of time.
- For example, if a toy car moves a greater distance than another toy car in one minute, then its speed is greater.

It is not essential for students to know how to calculate the speed if given the time and distance measurements or to identify direction of an object from a compass rose on a map.

Assessment Guidelines:

The objective of this indicator is to *compare* the motion of several objects in terms of their speeds and directions; therefore, the primary focus of assessment should be to detect similarities and differences between faster or slower objects and the direction of travel of those objects. However, appropriate assessments should require students to *illustrate* the slower and faster moving objects with pictures, diagrams, or words; *recognize* from pictures or diagrams which object is moving faster or slower; or *recognize* which direction objects are moving relative to other objects.

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3-5.3 Explain how the motion of an object is affected by the strength of a push or pull and the mass of the object.

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-5.2), students explained the importance of pushing and pulling to the motion of an object. Students have not been introduced to the concept of the strength of a push or pull and the mass of an object affecting the motion of an object in previous grades. In 5th grade, students will further develop the concept of the effects of various forces on motion (5-5.1) and how a change in force or a change in mass affects the motion of an object (5-5.6).

It is essential for students to know that the strength of a push or pull and the amount of mass of the object can affect the motion of an object at rest.

- The stronger the push or pull, the faster the object would move.
- The weaker the push or pull, the slower the object would move.
- *Mass* is how much matter is in an object.
- If the strength of the push or pull is the same, an object of greater mass would move slower than an object of lesser mass.

It is not essential for students to know how to measure the strength of the push or pull on an object or to measure the speed of the objects.

Assessment Guidelines:

The objective of this indicator is to *explain* how the motion of objects is affected by the strength of the push or pull and the mass of the object; therefore, the primary focus of assessment should be to construct a cause-(strength of push or pull, mass of object)-and-effect (motion of objects) model showing how the stronger or weaker pushes and pulls affect the motion of objects with more or less mass. However, appropriate assessments should also require students to *infer* which object is heavier or lighter if subjected to the same strength push or pull based on their location in a diagram; *infer* which objects of different masses would move faster if given the same strength push or pull; *infer* which objects of the same mass would move faster or slower if given stronger or weaker pushes or pulls; or *classify* objects based on characteristics listed above.

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3-5.4 Explain the relationship between the motion of an object and the pull of gravity.

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In first grade (1-5.2), students explained the importance of pushing and pulling to the motion of an object. In 4th grade, students will relate the Moon's pull of gravity on Earth to the high and low tides of the oceans (4-3.6), and they will relate Earth's pull of gravity on the Moon to keeping the Moon in orbit around Earth (4-3.6) as well as the Sun's pull of gravity on Earth to keeping Earth revolving around the Sun (4-3.3). Students will further develop the concept of the effects of the force of gravity on motion in 5th grade (5-5.1).

It is essential for students to know that the pull of gravity attracts objects to one another.

- The pull of gravity is everywhere.
- Earth's gravity pulls objects toward the center of Earth.
- The pull of gravity holds things down on Earth.
- Things fall to Earth because they are pulled straight down by Earth's gravity.
- No matter whether an object is dropped or thrown, it will always fall toward Earth's surface.

It is not essential for students to know how fast objects fall (acceleration due to gravity) or how masses and distances of objects affect the strength of the pull of gravity. They do not need to explain any quantitative relationships between the pull of gravity and the motion of objects.

Assessment Guidelines:

The objective of this indicator is to *explain* the relationship between the motion of objects and the pull of gravity; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the way the pull of gravity can affect the motion of objects. However, appropriate assessments should also require students to *infer* which direction an object will move if dropped or thrown on Earth; or *interpret* a diagram of objects being dropped or thrown and how the pull of gravity will affect them.

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3-5.5 Recall that vibrating objects produce sound and that vibrations can be transferred from one material to another.

Taxonomy level: 1.2-B Remember Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-5.3), students illustrated the fact that sound is produced by vibrating objects. Students will further develop the concept of sound energy being transferred to other materials and other forms of energy in 6th grade (6-5.2 and 6-5.4).

It is essential for students to know that sound vibrations are back and forth movements that occur very quickly.

- Vibrations can be transferred from one material to another causing that material to vibrate.
- Vibrations of materials causing sound can travel through solids, liquids, and gases, but they cannot travel through empty space where there are no particles of matter to vibrate.
- Sound moves better through some materials than others, for example, when a metal spoon is tied to a string and hit so that it vibrates, the sound can be heard through the string held to the ears better than through the air only.

It is not essential for students to know that sound vibrations travel at different speeds through different materials.

Assessment Guidelines:

The objective of this indicator is to *recall* that vibrating objects produce sound and that vibrations can be transferred from one material to another; therefore, the primary focus of assessment should be to remember that sound is produced by vibrating objects and to remember that a vibrating object can cause another object also to vibrate. However, appropriate assessments should also require students to *identify* the materials involved in the transfer of the vibrations of sound; or *recognize* on a picture or diagram the vibrating objects involved in the transfer of vibrations.

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3-5.6 Compare pitch and volume of different sounds.

Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concepts of pitch and volume of different sounds in previous grades. They will further develop these concepts in 8th grade (8-6.3) and also in high school Physical Science (PS-7.7).

It is essential for students to know that different sounds can have different pitches and volumes as follows:

Pitch

- *Pitch* of a sound is how high or low it is.
- For example, a man's voice has a lower pitch than a woman's voice, or a bird song has a higher pitch than the rumble of a heavy truck.
- Changing the length of the vibrating object can change pitch.
- A long string or wire will have a lower pitch than a short string or wire.

Volume

- *Volume* is the loudness or softness of a sound.
- For example, the sound from a person yelling is a louder volume than the sound from a person whispering even though the pitch is the same.
- It takes more force to produce loud sounds than soft sounds.

It is not essential for students to know how frequencies, wavelengths, or amplitude compare to the pitch and volume of sound waves.

Assessment Guidelines:

The objective of this indicator is to *compare* the pitch and volume of different sounds; therefore, the primary focus of assessment should be to detect similarities and differences between common sounds to see if they have higher or lower pitch or louder or softer volume. However, appropriate assessments should also require students to *exemplify* sounds with higher or lower pitch or louder or softer volume.

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3-5.7 Recognize ways to change the volume of sounds.

Taxonomy level: 1.1-A Remember Factual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of sounds in previous grades. In the 8th grade (8-6.3), students will study this concept in more depth as they study the factors that influence the basic properties of waves for example volume or amplitude.

It is essential for students to know that the volume of sounds can be changed.

Strength of the vibrations

- If the vibrations are made stronger or weaker by striking or plucking objects harder or softer, the volume will get louder or softer.
- If the force is decreased, the volume becomes softer.
- If the force is increased, the volume becomes louder.
- Tapping a desk lightly produces a soft sound while hitting a desk hard produces a loud sound.

Distance

- If the sources of the vibrations are *farther away*, the volume of the sound is softer.
- The closer the source of the vibrations, the louder the volume of the sound will be.

Radios, TVs, and disc players have loudness, or volume, controls. The volume can be turned up to make the sound louder or turned down to make the sound softer.

It is not essential for students to know that volume is related to the amplitude of sound waves.

Assessment Guidelines:

The objective of this indicator is to *recognize* ways to change the volume of sounds; therefore, the primary focus of assessment should be to recall ways that the volume of sounds could be changed. However, appropriate assessments should also require students to *recall* how to make an object produce a louder sound; or *identify* loud sounds or soft sounds from a list or illustration.

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3-5.8 Explain how the vibration of an object affects pitch.

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of how vibrations can affect pitch in previous grades. In 8th grade (8-6.3), students will summarize factors that influence the basic properties of waves (including frequency, amplitude, wavelength, and speed).

It is essential for students to know how the vibrations of an object affect pitch of a sound. Pitch depends on how fast an object is vibrating. Pitch is affected by the materials vibrating in the following ways:

Length

- *Length* of an object can change the vibration and cause the pitch to change.
- Shorter materials vibrate faster than longer ones.
- The faster a string, wire, or air in a tube vibrates, the higher the pitch of the sound.
- For example, when you shorten the length of a guitar string it makes a higher pitched sound.

Thickness

- *Thickness* can change pitch.
- Thinner strings or wires vibrate faster than thicker ones.
- Thinner vibrating materials have a higher pitch than thicker ones when they are vibrated.
- For example, when a thick rubber band and a thin rubber band are plucked, the thinner one produces a higher pitched sound.

Tightness

- *Tightness* of the stretch of the string or wire can change the pitch—the tighter the stretch of the string, the higher the pitch of the sound.
- For example, guitars and pianos have screws that can tighten the wire.
- Tightening the wire to tune the instrument can change the pitch.
- Tighter wires vibrate faster, making the pitch higher.

It is not essential for students to know why the speed of the vibrations affects the pitch of the sound or the quantitative relationship between frequency and energy of sound waves.

Assessment Guidelines:

The objective of this indicator is to *explain* how the vibration of an object affects pitch; therefore the primary focus of assessment should be to construct a cause-and-effect model of the factors that affect the pitch of various sounds and how they are related to the vibrations of objects. However, appropriate assessments should also require students to *illustrate* with pictures, diagrams, or words different factors that affect vibrations indicating which will produce the highest or lowest pitch; *compare* strings stretched to various degrees of tightness related to

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highest or lowest pitch when plucked; or *recognize* the relationship between smallest length and highest pitch.